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Sample assessment material

LEVEL 3 ALTERNATIVE ACADEMIC QUALIFICATION CAMBRIDGE ADVANCED NATIONAL IN

APPLIED SCIENCE

Certificate H051

Extended Certificate H151

For first teaching in 2025

F180: Fundamentals of science

Version 1.0 (June 2024)

Introduction

This is Sample Assessment Material (SAM) which has been produced for the OCR Level 3 Alternative Academic Qualification Cambridge Advanced National in Applied Science (Certificate) and OCR Level 3 Alternative Academic Qualification Cambridge Advanced National in Applied Science (Extended Certificate).

The SAM is an example exam paper that we publish alongside a new specification to help illustrate its intended style and structure when a qualification is first launched. We wanted to share the story of our assessment approach with you so when you look through the paper you will find we have pointed out certain features and explained the decisions we have made.

Resources to help support in teaching different areas of content can be found on the Cambridge Advanced National Applied Science webpage under 'Planning and teaching'.

Our exam papers are developed with our accessibility principles in mind. The Understanding the assessment guide tells you a little more about the principles and rationale underpinning our approach for the qualifications. The 'Command Words' are in both the Understanding the Assessment guide and the specification. These tell you what we mean by each command word and how students should approach the question and understand its demand.

Appendix B of the specification: **Command Words**, gives detail about what is expected of each command word that will be included in exams and mark schemes. You can include teaching around the expectations of these as part of your teaching.

You said, we did

During the development of this qualification, we talked extensively with teachers, subject experts, higher education institutions and our senior assessment teams to influence its structure, content and assessment materials. We then shared our final materials with teachers to make sure that they met their needs.

You told us that it was important to link all three sciences within our course and that you wanted mandatory units that covered the core knowledge for the course so that is what we have done through units F180 and F182.

You told us that you wanted optionality within the NEA units and a range of engaging optional units to choose from, so that is what we have provided.

You told us that knowledge areas such as cell structure and function, atomic structure, rates of reaction and forces were important parts of the subject. Some of these areas are also currently assessed in the EA in the OCR L3 Cambridge Technical in Applied Science and this has proven to be a valid and reliable approach so we've carried it over to this new qualification.

You told us that the order in which the units and concepts occur within our units needs to be considered carefully, with a rationale behind it. We have done this through clearly structured specification units linked to corresponding exam sections.

You told us that it was very important that knowledge and scientific concepts be assessed in a way that clearly links to real-life contexts and scenarios that students can easily engage with. We have done this by using clearly described scenarios with accessible language within our questioning.

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All students will sit the exam at the same time on the same day.

This exam will always be set and marked by us. Exams will be available in January and June each year. Students can resit this unit and the best result will be used to calculate the certification result.

Students will be provided with a Data, Formulae and Relationship Booklet. This will support them to complete the questions in the paper. Students are expected to become familiar with this booklet throughout the course.

Students must have a ruler (that measures cm and mm) in the exam with them.

Students can use a scientific or graphical calculator in this exam.

If students require additional answer space, lined paper will be available at the end of the answer booklet in a live question paper. Remember the question number(s) must be clearly shown.

OCR
Oxford Cambridge and RSA

<<Date>> – <<Morning/Afternoon>>

Level 3 Cambridge Advanced National (AAQ) in Applied Science (Certificate)

Level 3 Cambridge Advanced National (AAQ) in Applied Science (Extended Certificate)

H051/H151 Unit F180: Fundamentals of science

Sample Assessment Material (SAM)

Time allowed: 1 hour 30 minutes
XXX/XXXX

You must have:
- the Data, Formulae and Relationship Booklet
- a ruler (cm/mm)

You can use:
- a scientific or graphical calculator

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | Candidate number

First name(s)

Last name

Date of birth

INSTRUCTIONS
- Use black ink.
- Write your answer to each question in the space provided. You can use extra paper if you need to, but you must clearly show your candidate number, the centre number and the question numbers.
- In the live exam there might be lined pages at the end of the question paper for you to use if you need extra space. Remember, you must clearly show the question numbers.
- Answer **all** the questions.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **20** pages.

ADVICE
- Read each question carefully before you start your answer.

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Turn over

This unit is part of the Certificate and Extended Certificate qualifications.

The time allowed is designed to give students approximately one minute per mark plus reading time.

Each exam will be divided into 4 Sections (A-D) and each section will contain questions from the corresponding Topic Areas in the unit. Questions will not necessarily be in the same order as the teaching content.

The exam will always have 70 marks.

All questions in this exam are mandatory. A range of question types are used, including:

- Forced choice/controlled response questions (also known as multiple choice questions (MCQs)). These are typically 1 mark but may have a maximum of 4 marks for a single MCQ.
- Short answer closed response questions. These questions sometimes might involve diagrams or calculations. They are typically worth 1 to 4 marks.
- Extended constructed response questions with points-based marks schemes. They are typically worth 1 to 4 marks.

These question types allow us to assess the following Performance Objectives:

- PO1 – Show knowledge and understanding
- PO2 – Apply knowledge and understanding

There will be no extended constructed response questions with levels of response mark schemes in this exam paper.

The questions will sample content from across all Topic Areas; at least one question (or sub-part) will relate to each Topic Area. Sub-content topic areas will be sampled across exam papers, over time.

Answer **all** the questions.

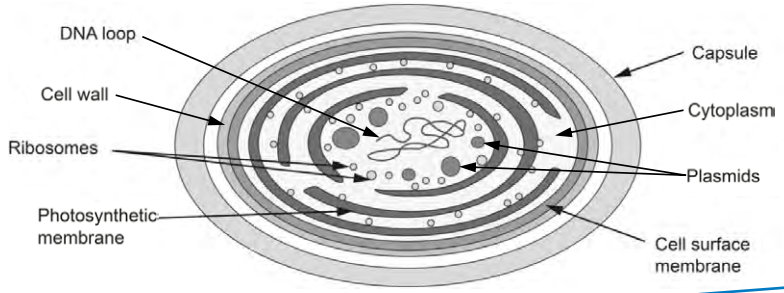
Section A (Biology) – 20 marks

1 A student is studying endosymbiosis in cells.

Endosymbiosis is seen when one organism lives inside of another and both organisms benefit from this relationship.

(a) Chloroplasts are thought to have evolved from a type of bacteria called cyanobacteria.

The diagram shows the structures of a cyanobacteria cell.



(i) Which **three** structures found in cyanobacteria are also found in plant cells?

Tick (✓) **three** boxes.

- Capsule ☐
- Cell surface membrane ☐
- Cell wall ☐
- Cytoplasm ☐
- DNA loop ☐
- Plasmids ☐

[3]

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Section A of the exam will always cover the biology content of the unit and will be worth 20 marks.

Where more than one response is required, we will indicate this in bold.

Students should use ticks (✓) to show their response to multiple choice questions.

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(ii) Some structures seen in the cyanobacteria cell in the diagram share the same function with components found in a chloroplast.

Complete the table to match the function of structures seen in the cyanobacteria cell to the component found in a chloroplast.

Component found in a chloroplast	Structure seen in the cyanobacteria cell
Outer membrane	.....
Stroma	.....
Thylakoids	.....

[3]

(b) A scanning electron microscope (SEM) can be used to view an individual cyanobacteria cell.

State **one** advantage and **one** disadvantage of using an SEM compared to a transmission electron microscope (TEM).

Advantage .....

.....

Disadvantage .....

.....

[2]

When we ask a 'complete the table' question and students are expected to write the answer in, it will either be presented like this or we may give a list of words in alphabetical order for students to choose from and then write it in the space given.

In this exam there will be between 30-40 PO1 (show knowledge and understanding) marks. This proportion of PO1 marks helps to assess the fundamental knowledge needed for the course of study.
Question 1(b) is an example of a question targeting PO1. Question 1(b) requires students to show their understanding of SEM and TEM microscopes.

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When a question needs an expected number of discrete responses, the number needed will be given as a word in bold, and we will also give the appropriate number of structured answer spaces to write in.

In this exam, there will be between 30-40 PO2 (apply knowledge and understanding) marks. Questions targeting PO2 require students to apply their knowledge and understanding to scientific contexts. Questions 2(b)(i) and 2(b)(ii) are examples of students being required to apply their knowledge and understanding of Mathematical skills to a specific biological context.

Where a question asks students to explain, they must show (PO1) or apply (PO2) their understanding of knowledge. It is not enough to recall or apply knowledge alone.

This question requires students to explain one impact, which requires the impact being explained to be clear as well as a reason for this impact on the activity of abnormal sperm cells.

2 A group of scientists are investigating sperm cells in humans.

Normal-functioning sperm cells contain many mitochondria, packed into the middle piece.

(a) The aerobic phase of cellular respiration takes place inside each mitochondrion.

State **two** structural components of the mitochondria involved in the aerobic phase of respiration.

1 .....

2 .....

[2]

(b) The scientists estimate that normal sperm cells contain 60 mitochondria in the middle piece.

The table shows relatively lower numbers of mitochondria found in a sample of abnormal sperm cells.

41	32	42	49	27
46	35	44	48	37

(i) Calculate the mean number of mitochondria found in the abnormal sperm cells.

Mean number of mitochondria = ... **[1]**

(ii) Calculate the percentage difference between the mean number of mitochondria found in abnormal sperm cells and the estimated number of mitochondria in normal sperm cells.

Give your answer to **2** decimal places.

Percentage difference = ... % **[1]**

(iii) Explain **one** impact of low numbers of mitochondria on the activity of abnormal sperm cells.

.....

.....

.....

..... **[2]**

The number of marks for a question will always be given at the end of the question and will always be right aligned.

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Questions 3(a)(i) and 3(a)(ii) assess content from B3: Structure and function of biological molecules, and specifically 3.1.3 which focuses on the structure and function of proteins. These questions are PO1 because they require students to show their understanding of how carboxylic and amino groups form the peptide bond, and the differences between the four levels of organisation in proteins. Minimal context is required for these questions.

3 Pea protein is extracted from yellow peas.

(a) Pea protein provides a wide range of amino acids in the human diet.

(i) The amino acids can form dipeptides.

Describe the process of dipeptide formation.

.....

.....

.....

..... **[2]**

(ii) Pea proteins have a secondary level of organisation.

What is the secondary level of organisation in proteins?

Tick (✓) **one** box.

Folding of a single polypeptide chain to form an α-helix or β-pleated sheet ☐

More than one polypeptide chain folded to form a 3D shape ☐

The sequence of amino acids in a polypeptide chain ☐

3D folding of a single polypeptide chain due to side-chain interactions ☐

[1]

(b) Pea plants are grown as an agricultural crop.

Pea plants are often vulnerable to diseases.

(i) The distribution of diseased pea plants in a field is determined using a random sampling technique.

State **one** benefit and **one** limitation of using random sampling.

Benefit .....

.....

Limitation .....

.....

[2]

(ii) State **one** climatic abiotic factor affecting the distribution of pea plants in an agricultural field.

..... **[1]**

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Question 3(a)(ii) is an example of a forced choice/controlled response question. When students are asked to tick boxes, they will be directed how many to tick.
In this instance, if more than one box is ticked, zero marks will be awarded.

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Section B (Chemistry) – 20 marks

4 Sulfur (atomic number 16) is an element in the Earth's crust. It is released into the atmosphere when a volcano erupts.

(a) The two most abundant isotopes of sulfur are sulfur-32 and sulfur-34.

(i) Explain why sulfur-32 and sulfur-34 are described as isotopes of sulfur.

.....

..... **[1]**

(ii) A scientist analyses a sample of sulfur from a volcano and finds that there are three isotopes present. They determine the relative masses and percentage (%) abundances of these isotopes:

Isotope	Symbol	Abundance (%)
Sulfur-32	^{32}S	95.02
Sulfur-33	^{33}S	0.77
Sulfur-34	^{34}S	4.21

Calculate the relative atomic mass of the sample of sulfur.

Give your answer to **two** decimal places.

Relative atomic mass = ... **[2]**

(b) Complete the electron configuration of sulfur, using sub-shell notation.

Electron configuration of sulfur = $1s^2$ ..... **[1]**

In calculation questions, if the correct answer is present, we will award full marks and anything else in the answer space will be ignored. In the absence of the correct answer, we will award separate marks for working. For example, one mark is awarded for the rounding to two decimal places.

This question provides an example of a question where students are required to complete an electron configuration. Students may use the formulae, data and relationships booklet to help them.

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5 Calcium carbonate, $CaCO_3$, occurs naturally in the Earth's crust as limestone and chalk.

(a) Calcium carbonate decomposes when heated strongly to form calcium oxide and carbon dioxide.

$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

(i) Calculate the number of moles of CO_2 produced when 2000 g of $CaCO_3$ decomposes.

Give your answer to an appropriate number of significant figures.

Molar mass of $CaCO_3$ = 100.1 g mol^{-1}

Number of moles of CO_2 = ... **[2]**

(ii) Calculate the volume of CO_2 formed at room temperature and pressure (RTP).

Molar gas volume = 24.0 dm^3 mol^{-1} at RTP

Volume of CO_2 = ... dm^3 **[1]**

(b) Calcium carbonate reacts with nitric acid.

Explain the type of reaction between calcium carbonate and nitric acid.

.....

..... **[1]**

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Key information required by students to answer the question will be signposted in questions.

Appendix B in the specification contains a glossary of Command Words which could be used in this exam. The glossary tells you what we mean by each command word.

All equations from the unit content will be provided to candidates on the data, formulae and relationships booklet to ensure that the focus of the assessment is on the application of the skills associated with the use of these equations, rather than the need to recall the equations themselves.

This is an example of a command word that does not have a definition but is a commonly used word whose meaning is made clear from the context in which it is used. Other similar command words that may appear in this exam include: which, where, when, why, and how.

6 Properties of substances are determined by the type of structure and bonding present.

(a)

(i) What is a covalent bond?

.....

..... **[1]**

(ii) Na_2CO_3 contains the carbonate ion, CO_3^{2-}.

Draw a dot and cross diagram for the carbonate ion.

[2]

This is an example of a question where we expect students to be able to apply their knowledge and understanding of how to construct dot and cross diagrams for ions.

(b) A substance **X** has the following properties:

- a high melting point
- does not conduct electricity when solid
- does not conduct electricity when molten
- does not dissolve in water.

Which type of structure is substance **X**?

Tick (✓) **one** box.

Students should use a single tick (✓) in one box to show their response to multiple choice questions with the instruction Tick (✓) **one** box. The number of ticks required is emboldened to remind students.

Giant ionic ☐

Giant covalent ☐

Giant metallic ☐

Simple molecular ☐

[1]

(c) Aluminium nitrate is an ionic compound.

What is the correct formula of aluminium nitrate?

Tick (✓) **one** box.

$AlNO_3$ ☐

Al_3NO_3 ☐

$(Al_2NO_3)_3$ ☐

$Al(NO_3)_3$ ☐

[1]

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This is an example of a question where we require students to use explicit information from the provided Boltzmann distribution curve, which will help them to structure their answer.

7 Catalysts are important in the chemical industry because they speed up chemical reactions and remain unchanged at the end of the reaction.

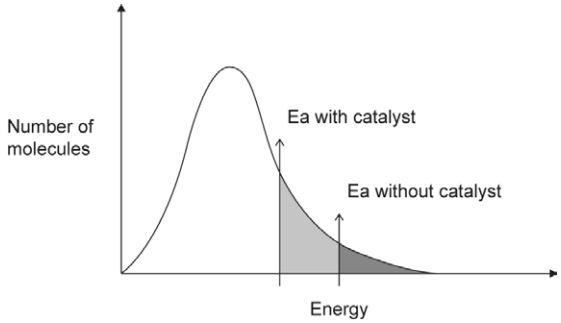
(a) Explain what is meant by the activation energy (E_a) of a chemical reaction.

.....

..... **[1]**

The activation energy has been represented in both word and symbolic form here to ensure that candidates more familiar with one term or another can readily access the question, and also to help introduce the symbol which is shown in the Boltzmann distribution curve in question 7(b).

(b) Use the Boltzmann distribution curve to explain the effect of a catalyst on a reaction.



.....

.....

.....

.....

..... **[2]**

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Question 8(a) is an example of a question where marks are available for both the correct reactants (left hand side of the equation, 1 mark) and products (right hand side of the equation, 1 mark).

8 Butane and ethanol are both useful fuels.

(a) Write the balanced equation for the complete combustion of ethanol.

..... **[2]**

(b) Explain **one** advantage of using ethanol as a fuel rather than butane.

.....

..... **[1]**

(c) Butanal is a derivative of butane.

Draw the displayed formula of butanal.

When students are required to draw something for their answer, they will be given a blank space between the command line and the mark tariff for the question. Students are expected to get the full displayed formula for butanal correct for the mark. Providing the structural formula of butanal will receive no marks.

[1]

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The number of lines given for a question indicate the approximate length of the answer required.

Section C (Physics) – 20 marks

9 Some cranes use electricity to raise, lower and move loads.

(a) What is potential difference?

.....

..... **[1]**

(b) An electric crane lifts a 100 kg mass through a vertical height of 15 m in a time of 1.5 minutes.

(i) Calculate the work done to lift the mass.

Work done = ... J **[2]**

(ii) The crane is 37% efficient. The work done to lift the mass is approximately 15 000 J.

Calculate the input power to the crane.

Input power = ...W **[3]**

(c) The potential difference across the crane's motor is 600 V.

Calculate the current drawn by the crane.

Current = ... A **[2]**

Brief contexts will sometimes be used to show the relevance of scientific principles and concepts to the real world.

The principle of 'error carried forward, ECF' would be applied in the case of questions 9(b)(ii) and 9(c). This ensures that one mistake in question 9(b)(i) is not excessively penalised and that marks are attributed based on the maths skills used.

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This question is assessing PO2, because the response requires knowledge and understanding to be applied to the context of the situation in the question.

We have kept the context deliberately brief to aid accessibility, i.e. to ensure the focus is on the assessment of the taught content and not English comprehension.

If students find it easier to draw a diagram with appropriate annotations, the following sentence will be seen, 'You may draw a labelled diagram'. Full marks can be achieved through sufficient detail from a diagram.

This is an example of an extended constructed response question with a points-based mark scheme. The question is allocated to PO1 due to the explicit reference in the breadth and depth column of P3.2.3 to the mechanism of direct and indirect ionisation of biological molecules. Students can achieve up to 4 marks by making four correct points explaining how nuclear radiation can indirectly damage DNA.

10 A patient has visited their doctor to discuss bone pain that they are experiencing. They are referred for an X-ray to look for any problems in the bones.

(a) Explain how X-ray photons are produced in an X-ray tube.

You may draw a labelled diagram.

.....

.....

.....

.....

.....

..... **[3]**

(b) The nuclear medicine department of a hospital uses radionuclides to treat bone cancer.

List **three** types of nuclear radiation in order of **decreasing** mass that can be emitted from radionuclides.

Heaviest 1 .....

2 .....

Lightest 3 .....

[1]

(c) Explain how nuclear radiation can damage DNA indirectly.

.....

.....

.....

.....

.....

.....

This type of question requires students to list the three types of nuclear radiation in order of decreasing mass. Emboldening of the words '**three**' and '**decreasing**' has been used to focus students on two key facets of the question.

The answer lines have also been scaffolded to further support understanding of the command line.

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This question (10(d)) is assessing PO2, using data interpretation skills which are included in HSW6.

(d) Radionuclides are used in radiotherapy to treat bone cancers.

The radionuclide is:

- injected into the patient
- absorbed by the bones
- kills bone cells by ionising them.

Where processes or practical methods are detailed in questions, these will be presented as bulleted or numbered lists to aid with accessibility.

The table shows the properties of four radionuclides that are available:

Radionuclide	Emission	Half-life
A	gamma	2.6 years
B	gamma	6 hours
C	beta	12.3 years
D	beta	50 days

Explain why Radionuclide **D** is chosen for this radiotherapy.

The number of lines given for a question indicate the approximate length of the answer required.

This question expects students to apply their knowledge of the properties of nuclear radiation to the information provided in the table to help them answer the question.

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

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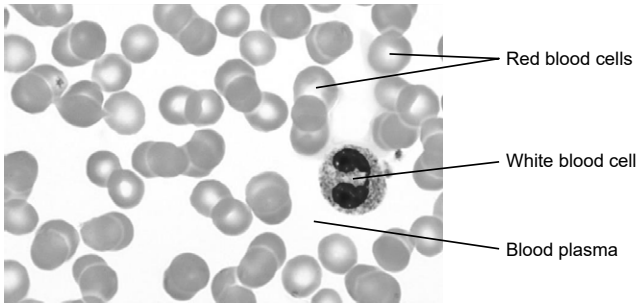
Section D (Practicals) – 10 marks

11 A laboratory technician prepares a temporary, stained microscope slide of a blood smear.

The photomicrograph shows a white blood cell in the blood smear.



(a)

(i) Identify **two** differences between the white and red blood cells shown in the photomicrograph.

1 .....

.....

2 .....

..... **[2]**

(ii) The actual vertical length of the white blood cell in the photomicrograph is 22 μm.

Calculate the magnification of the image.

Magnification = × ..... **[3]**

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Section D explicitly assesses the application of knowledge and understanding of practicals 1-6 from the unit specification. Knowledge and understanding from the rest of the unit specification will help to answer the questions in Section D.

This question is linked to Practical 1. This section will be PO2-based.

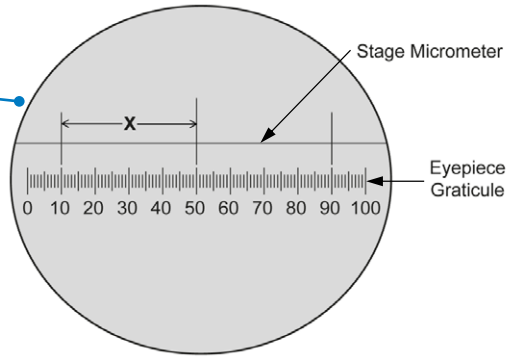
Question 11(a)(i) is an identify question that assesses PO2. This question asks students to name two differences from the stimulus. The two marks are for providing two distinct differences. The mark scheme provides a number of example answers, but we will credit any appropriate response to this question.

15

(b) The technician uses an eyepiece graticule to measure the dimensions of blood cells.

- The eyepiece graticule is calibrated using a stage micrometer.
- The stage micrometer is viewed alongside the eyepiece graticule scale line.
- The eyepiece graticule scale line contains 100 divisions.

The drawing shows the two scale lines alongside each other.



(i) The distance **X** on the stage micrometer is **0.1 mm**.

Calculate the length of an eyepiece graticule division, using the drawing.

Give your answer in micrometres.

Length = ... µm **[3]**

Diagrams will always be in grayscale.

Content in this exam will have links to the 'How Science Works Concepts and Skills'. Question 11(b)(i) is linked to HSW4.

Q11(b)(i) if the correct answer of 2.5 µm is given, full marks will be awarded.
If not, 1 mark (max) will be given for any of the working out shown:

- length of **X** = 0.1mm = 100 µm (1)
- 40 eyepiece graticule divisions = 100 µm (1)
- 1 eyepiece graticule division = 100 ÷ 40 = 2.5 µm (1)

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(ii) The technician uses the calibrated eyepiece graticule to estimate the width of five different white blood cells found in the stained blood smear.

The table shows the measurements recorded.

Replicate	Width of white blood cell (μm)
1	17.0
2	19.0
3	22.0
4	20.5
5	16.5

The width of the white blood cell shown in the photomicrograph is 18.0 μm.

Explain the extent of the variation of measurements shown in the table.

.....

.....

..... **[1]**

(iii) Explain **one** improvement to be made by the technician to obtain a more accurate estimate for the width of white blood cells.

.....

.....

..... **[1]**

END OF QUESTION PAPER

Students are expected to provide a single reason for why the width of the white blood cell varies as it does, from the stimulus table provided.

Content in this exam will have links to the 'How Science Works Concepts and Skills'. Question 11(b)(iii) is linked to HSW6.

Tells students there are no more questions to answer.

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